

WHAT IS CLAIMED IS:

1. A light-emitting semiconductor device which comprises an n-layer of n-type gallium nitride compound semiconductor ( $\text{Al}_x\text{Ga}_{1-x}\text{N}$ ; inclusive of  $x=0$  ) and an i-layer of insulating gallium nitride compound semiconductor ( $\text{Al}_x\text{Ga}_{1-x}\text{N}$ ; inclusive of  $x=0$  ) doped with p-type impurities, wherein at least one of said n-layer and said i-layer is of double-layer structure, the respective layers of said double-layer structure having different concentrations.

2. A light-emitting semiconductor device as claimed in Claim 1, wherein said n-layer is of double-layer structure including an n-layer of low carrier concentration and an  $n^+$ -layer of high carrier concentration, the former being adjacent to said i-layer.

3. A light-emitting semiconductor device as claimed in Claim 1, wherein said i-layer is of double-layer structure including an  $i_L$ -layer of low impurity concentration containing p-type impurities in comparatively low concentration and an  $i_H$ -layer of high impurity concentration containing p-type impurities in comparatively high concentration, the former being

adjacent to said n-layer.

4. A light-emitting semiconductor device as claimed in Claim 1, wherein said n-layer is of double-layer structure including an n-layer of low carrier concentration and an  $n^+$ -layer of high carrier concentration, the former being adjacent to said i-layer, and said i-layer is of double-layer structure including an  $i_L$ -layer of low impurity concentration containing p-type impurities in comparatively low concentration and an  $i_H$ -layer of high impurity concentration containing p-type impurities in comparatively high concentration, the former being adjacent to said n-layer.

5. A light-emitting semiconductor device as claimed in Claim 1, wherein the thickness of said n-layer is  $2.5 - 12 \mu\text{m}$ .

6. A light-emitting semiconductor device as claimed in Claim 1, wherein the carrier concentration of said n-layer is  $1 \times 10^{14} - 1 \times 10^{19} / \text{cm}^3$ .

7. A light-emitting semiconductor device as claimed in Claim 2, wherein the thickness of said n-

layer of low carrier concentration is  $0.5 - 2 \mu\text{m}$  and the thickness of said  $n^+$ -layer of high carrier concentration is  $2 - 10 \mu\text{m}$ .

8. A light-emitting semiconductor device as claimed in Claim 2, wherein the carrier concentration of said  $n$ -layer of low carrier concentration is  $1 \times 10^{14} - 1 \times 10^{17} / \text{cm}^3$  and the carrier concentration of said  $n^+$ -layer of high carrier concentration is  $1 \times 10^{17} - 1 \times 10^{19} / \text{cm}^3$ .

9. A light-emitting semiconductor device as claimed in Claim 1, wherein the thickness of said  $i$ -layer is  $0.03 - 1.3 \mu\text{m}$ .

10. A light-emitting semiconductor device as claimed in Claim 1, wherein the impurity concentration of said  $i$ -layer is  $1 \times 10^{16} - 5 \times 10^{20} / \text{cm}^3$ .

11. A light-emitting semiconductor device as claimed in Claim 3, wherein the thickness of said  $i_L$ -layer of low impurity concentration is  $0.01 - 1 \mu\text{m}$  and the thickness of said  $i_H$ -layer of high impurity concentration is  $0.02 - 0.3 \mu\text{m}$ .

12. A light-emitting semiconductor device as claimed in Claim 3, wherein the impurity concentration of said  $i_L$ -layer of low impurity concentration is  $1 \times 10^{16} - 5 \times 10^{19} / \text{cm}^3$  and the impurity concentration of said  $i_H$ -layer of high impurity concentration is  $1 \times 10^{19} - 5 \times 10^{20} / \text{cm}^3$ .

13. A light-emitting semiconductor device as claimed in Claim 2, wherein said  $n^+$ -layer of high carrier concentration is doped with silicon.

14. A light-emitting semiconductor device as claimed in Claim 4, wherein said  $n^+$ -layer of high carrier concentration is doped with silicon.

15. A light-emitting semiconductor device as claimed in Claim 3, wherein both said  $i_L$ -layer of low impurity concentration and said  $i_H$ -layer of high impurity concentration are doped with zinc, the amount of doped zinc in said  $i_H$ -layer of high impurity concentration being higher than that in said  $i_L$ -layer of low impurity concentration.

16. A light-emitting semiconductor device as claimed in Claim 4, wherein both said  $i_L$ -layer of low impurity concentration and said  $i_H$ -layer of high

impurity concentration are doped with zinc, the amount of doped zinc in said  $i_H$ -layer of high impurity concentration being higher than that in said  $i_L$ -layer of low impurity concentration.

17. A method for producing a light-emitting semiconductor device comprising an n-layer of n-type gallium nitride compound semiconductor ( $Al_xGa_{1-x}N$ ; inclusive of  $x=0$  ) and an i-layer of insulating gallium nitride compound semiconductor ( $Al_xGa_{1-x}N$ ; inclusive of  $x=0$  ) doped with p-type impurities from organometal compound by vapor phase epitaxy, comprising the steps of:

feeding a silicon-containing gas and other raw material gases together at a controlled mixing ratio to a substrate; and

growing said n-layer having a controlled conductivity.

18. A method as claimed in Claim 17, comprising:

growing an  $n^+$ -layer of high carrier concentration, which is an n-type gallium nitride compound semiconductor ( $Al_xGa_{1-x}N$ ; inclusive of  $x=0$  ) having a comparatively high conductivity, on said substrate

having a buffer layer of aluminum nitride formed thereon, by feeding said silicon-containing gas and said other raw material gases together at a controlled mixing ratio; and

growing an n-layer of low carrier concentration, which is an n-type gallium nitride compound semiconductor ( $\text{Al}_x\text{Ga}_{1-x}\text{N}$ ; inclusive of  $x=0$  ) having a comparatively low conductivity, on said  $n^+$ -layer, by feeding said raw material gases excluding said silicon-containing gas.

19. A method for producing a gallium nitride group compound semiconductor by using an organometallic compound vapor phase epitaxy, comprising the steps of:

setting a mixing ratio of a silicon-containing gas and other raw material gases during said vapor phase epitaxy at a desired value in a range which increases substantially in proportion to a conductivity (1/resistivity) of said gallium nitride group compound semiconductor so as to control conductivity (1/resistivity) of said gallium nitride group compound semiconductor at a desired value; and

forming said gallium nitride group compound semiconductor by feeding said silicon-containing gas and other raw material gases at a mixing ratio set above.

20. A method for producing a gallium nitride group compound semiconductor by using an organometallic compound vapor phase epitaxy, comprising the steps of:

setting a mixing ratio of a silicon-containing gas and other raw material gases during said vapor phase epitaxy at a desired value in a range which increases substantially in proportion to an electron concentration of said gallium nitride group compound semiconductor so as to control a carrier concentration of said gallium nitride group compound semiconductor at a desired value; and

forming said gallium nitride group compound semiconductor by feeding said silicon-containing gas and other raw material gases at a mixing ratio set above.

21. A method for producing a gallium nitride group compound semiconductor according to claim 19, wherein said gallium nitride group compound semiconductor is  $\text{Al}_x\text{Ga}_{1-x}\text{N}$  ( $0 \leq x \leq 1$ ).

22. A method for producing a gallium nitride group compound semiconductor according to claim 20, wherein said gallium nitride group compound semiconductor is  $\text{Al}_x\text{Ga}_{1-x}\text{N}$  ( $0 \leq x \leq 1$ ).

23. A method for producing a gallium nitride group compound semiconductor according to claim 19, wherein said gallium nitride group compound semiconductor is GaN.

24. A method for producing a gallium nitride group compound semiconductor according to claim 20, wherein said gallium nitride group compound semiconductor is GaN.

25. A method for producing a gallium nitride group compound semiconductor according to claim 19, wherein said conductivity (1/resistivity) is not less than  $3.3/\Omega\text{cm}$ .

26. A method for producing a gallium nitride group compound semiconductor according to claim 21, wherein said conductivity (1/resistivity) is not less than  $3.3/\Omega\text{cm}$ .

27. A method for producing a gallium nitride group compound semiconductor according to claim 23, wherein said conductivity (1/resistivity) is not less than  $3.3/\Omega\text{cm}$ .

28. A method for producing a gallium nitride group compound semiconductor according to claim 20, wherein said electron concentration is not less than  $6 \times 10^{16}/\text{cm}^3$ .



29. A method for producing a gallium nitride group compound semiconductor according to claim 22, wherein said electron concentration is not less than  $6 \times 10^{16}/\text{cm}^3$ .

30. A method for producing a gallium nitride group compound semiconductor according to claim 24, wherein said electron concentration is not less than  $6 \times 10^{16}/\text{cm}^3$ .

31. A method for producing a gallium nitride group compound semiconductor according to claim 19, wherein said conductivity (1/resistivity) is ranging from  $3.3/\Omega\text{cm}$  to  $1.3 \times 10^2/\Omega\text{cm}$ .

32. A method for producing a gallium nitride group compound semiconductor according to claim 21, wherein said conductivity (1/resistivity) is ranging from  $3.3/\Omega\text{cm}$  to  $1.3 \times 10^2/\Omega\text{cm}$ .

33. A method for producing a gallium nitride group compound semiconductor according to claim 23, wherein said conductivity (1/resistivity) is ranging from  $3.3/\Omega\text{cm}$  to  $1.3 \times 10^2/\Omega\text{cm}$ .

34. A method for producing a gallium nitride group compound semiconductor according to claim 20, wherein said electron concentration is ranging from  $6 \times 10^{16}/\text{cm}^3$  to  $3 \times 10^{18}/\text{cm}^3$ .

35. A method for producing a gallium nitride group compound semiconductor according to claim 22, wherein said electron concentration is ranging from  $6 \times 10^{16}/\text{cm}^3$  to  $3 \times 10^{18}/\text{cm}^3$ .

36. A method for producing a gallium nitride group compound semiconductor according to claim 24, wherein said electron concentration is ranging from  $6 \times 10^{16}/\text{cm}^3$  to  $3 \times 10^{18}/\text{cm}^3$ .

37. A method for producing a gallium nitride group compound semiconductor according to claim 19, wherein said gallium nitride group compound semiconductor is formed on or above a buffer layer which is formed on a sapphire substrate.

38. A method for producing a gallium nitride group compound semiconductor according to claim 20, wherein said gallium nitride group compound semiconductor is formed on or above a buffer layer which is formed on a sapphire substrate.

39. A method for producing a gallium nitride group compound semiconductor according to claim 21, wherein said gallium nitride group compound semiconductor is formed on or above a buffer layer which is formed on a sapphire substrate.

40. A method for producing a gallium nitride group compound semiconductor according to claim 22, wherein said gallium nitride group compound semiconductor is formed on or above a buffer layer which is formed on a sapphire substrate.

41. A method for producing a gallium nitride group compound semiconductor according to claim 25, wherein said gallium nitride group compound semiconductor is formed on or above a buffer layer which is formed on a sapphire substrate.

42. A method for producing a gallium nitride group compound semiconductor according to claim 28, wherein said gallium nitride group compound semiconductor is formed on or above a buffer layer which is formed on a sapphire substrate.

43. A method for producing a gallium nitride group compound semiconductor according to claim 31, wherein said gallium nitride group compound semiconductor is formed on or above a buffer layer which is formed on a sapphire substrate.

44. A method for producing a gallium nitride group compound semiconductor according to claim 34, wherein said gallium nitride group compound semiconductor is formed on or above a buffer layer which is formed on a sapphire substrate.

45. A method for producing a gallium nitride group compound semiconductor according to claim 37, wherein said buffer layer is formed on said sapphire substrate by using an organometallic compound vapor phase epitaxy at a growth temperature lower than that of said gallium nitride group compound semiconductor.

46. A method for producing a gallium nitride group compound semiconductor according to claim 38, wherein said buffer layer is formed on said sapphire substrate by using an organometallic compound vapor phase epitaxy at a growth temperature lower than that of said gallium nitride group compound semiconductor.

47. A method for producing a gallium nitride group compound semiconductor according to claim 39, wherein said buffer layer is formed on said sapphire substrate by using an organometallic compound vapor phase epitaxy at a growth temperature lower than that of said gallium nitride group compound semiconductor.

48. A method for producing a gallium nitride group compound semiconductor according to claim 40, wherein said buffer layer is formed on said sapphire substrate by using an organometallic compound vapor phase epitaxy at a growth temperature lower than that of said gallium nitride group compound semiconductor.

49. A method for producing a gallium nitride group compound semiconductor according to claim 41, wherein said buffer layer is formed on said sapphire substrate by using an organometallic compound vapor phase epitaxy at a growth temperature lower than that of said gallium nitride group compound semiconductor.

50. A method for producing a gallium nitride group compound semiconductor according to claim 42, wherein said buffer layer is formed on said sapphire substrate by using an organometallic compound vapor phase epitaxy at a growth temperature lower than that of said gallium nitride group compound semiconductor.

51. A method for producing a gallium nitride group compound semiconductor according to claim 43, wherein said buffer layer is formed on said sapphire substrate by using an organometallic compound vapor phase epitaxy at a growth temperature lower than that of said gallium nitride group compound semiconductor.

52. A method for producing a gallium nitride group compound semiconductor according to claim 44, wherein said buffer layer is formed on said sapphire substrate by using an organometallic compound vapor phase epitaxy at a growth temperature lower than that of said gallium nitride group compound semiconductor.

53. A method for producing a gallium nitride group compound semiconductor by an organometallic compound vapor phase epitaxy, comprising the steps of:

setting a supplying rate of silicon (Si) to gallium (Ga) in a reaction chamber during said vapor phase epitaxy at a desired value in a range from 0.1 to 3 as a converted values so as to control a conductivity (1/resistivity) of said gallium nitride group compound semiconductor at a desired value, where said values 0.1 and 3 are the values obtained from gas flow rates, in case that an amount of said gallium (Ga) is converted into a flow rate of hydrogen bubbling trimethyl

gallium (TMG) at a temperature of  $-15^{\circ}\text{C}$  and an amount of said silicon (Si) is converted into a flow rate of a gas diluted to 0.86 ppm.

54. A method for producing a gallium nitride group compound semiconductor by an organometallic compound vapor phase epitaxy, comprising the steps of:

setting a supplying rate of silicon (Si) to  $\text{NH}_3$  in a reaction chamber during said vapor phase epitaxy at a desired value in a range from  $8.6 \times 10^{-10}$  to  $2.6 \times 10^{-8}$ , so as to control a conductivity (1/resistivity) of said gallium nitride group compound semiconductor at a desired value.

55. A method for producing a gallium nitride group compound semiconductor by an organometallic compound vapor phase epitaxy, comprising the steps of:

setting a supplying rate of silicon (Si) to gallium (Ga) in a reaction chamber during said vapor phase epitaxy at a desired value in a range from 0.1 to 3 as a converted values so as to control a carrier concentration of said gallium nitride group compound semiconductor at a desired value, where said values 0.1 and 3 are the values obtained from gas flow rates, in case that an amount of said gallium (Ga) is converted into a flow rate of hydrogen bubbling trimethyl gallium (TMG) at a temperature of  $-15^{\circ}\text{C}$  and an amount of said silicon (Si) is converted into a flow rate of a gas diluted to 0.86 ppm.

56. A method for producing a gallium nitride group compound semiconductor by an organometallic compound vapor phase epitaxy, comprising the steps of:

setting a supplying rate of silicon (Si) to  $\text{NH}_3$  in a reaction chamber during said vapor phase epitaxy at a desired value in a range from  $8.6 \times 10^{-10}$  to  $2.6 \times 10^{-8}$ , so as to control a carrier concentration of said gallium nitride group compound semiconductor at a desired value.

57. A method for producing a gallium nitride group compound semiconductor according to claim 53, wherein said gallium nitride group compound semiconductor is  $\text{Al}_x\text{Ga}_{1-x}\text{N}$  ( $0 \leq x \leq 1$ ).

58. A method for producing a gallium nitride group compound semiconductor according to claim 54, wherein said gallium nitride group compound semiconductor is  $\text{Al}_x\text{Ga}_{1-x}\text{N}$  ( $0 \leq x \leq 1$ ).

59. A method for producing a gallium nitride group compound semiconductor according to claim 55, wherein said gallium nitride group compound semiconductor is  $\text{Al}_x\text{Ga}_{1-x}\text{N}$  ( $0 \leq x \leq 1$ ).

60. A method for producing a gallium nitride group compound semiconductor according to claim 56, wherein said gallium nitride group compound semiconductor is  $\text{Al}_x\text{Ga}_{1-x}\text{N}$  ( $0 \leq x \leq 1$ ).

61. A method for producing a gallium nitride group compound semiconductor according to claim 53, wherein said gallium nitride group compound semiconductor is  $\text{GaN}$ .

62. A method for producing a gallium nitride group compound semiconductor according to claim 54, wherein said gallium nitride group compound semiconductor is GaN.

63. A method for producing a gallium nitride group compound semiconductor according to claim 55, wherein said gallium nitride group compound semiconductor is GaN.

64. A method for producing a gallium nitride group compound semiconductor according to claim 56, wherein said gallium nitride group compound semiconductor is GaN.

65. A method for producing a gallium nitride group compound semiconductor according to claim 53, wherein said conductivity (1/resistivity) is not less than  $3.3/\Omega\text{cm}$ .

66. A method for producing a gallium nitride group compound semiconductor according to claim 54, wherein said conductivity (1/resistivity) is not less than  $3.3/\Omega\text{cm}$ .

67. A method for producing a gallium nitride group compound semiconductor according to claim 57, wherein said conductivity (1/resistivity) is not less than  $3.3/\Omega\text{cm}$ .

68. A method for producing a gallium nitride group compound semiconductor according to claim 58, wherein said conductivity (1/resistivity) is not less than  $3.3/\Omega\text{cm}$ .

69. A method for producing a gallium nitride group compound semiconductor according to claim 61, wherein said conductivity (1/resistivity) is not less than  $3.3/\Omega\text{cm}$ .



70. A method for producing a gallium nitride group compound semiconductor according to claim 62, wherein said conductivity (1/resistivity) is not less than  $3.3/\Omega\text{cm}$ .

71. A method for producing a gallium nitride group compound semiconductor according to claim 55, wherein said electron concentration is not less than  $6 \times 10^{16}/\text{cm}^3$ .

72. A method for producing a gallium nitride group compound semiconductor according to claim 56, wherein said electron concentration is not less than  $6 \times 10^{16}/\text{cm}^3$ .

73. A method for producing a gallium nitride group compound semiconductor according to claim 59, wherein said electron concentration is not less than  $6 \times 10^{16}/\text{cm}^3$ .

74. A method for producing a gallium nitride group compound semiconductor according to claim 60, wherein said electron concentration is not less than  $6 \times 10^{16}/\text{cm}^3$ .

75. A method for producing a gallium nitride group compound semiconductor according to claim 53, wherein said conductivity (1/resistivity) is ranging from  $3.3/\Omega\text{cm}$  to  $1.3 \times 10^2/\Omega\text{cm}$ .

76. A method for producing a gallium nitride group compound semiconductor according to claim 54, wherein said conductivity (1/resistivity) is ranging from  $3.3/\Omega\text{cm}$  to  $1.3 \times 10^2/\Omega\text{cm}$ .

77. A method for producing a gallium nitride group compound semiconductor according to claim 57, wherein said conductivity (1/resistivity) is ranging from  $3.3/\Omega\text{cm}$  to  $1.3 \times 10^2/\Omega\text{cm}$ .

78. A method for producing a gallium nitride group compound semiconductor according to claim 58, wherein said conductivity (1/resistivity) is ranging from  $3.3/\Omega\text{cm}$  to  $1.3 \times 10^2/\Omega\text{cm}$ .

79. A method for producing a gallium nitride group compound semiconductor according to claim 61, wherein said conductivity (1/resistivity) is ranging from  $3.3/\Omega\text{cm}$  to  $1.3 \times 10^2/\Omega\text{cm}$ .

80. A method for producing a gallium nitride group compound semiconductor according to claim 62, wherein said conductivity (1/resistivity) is ranging from  $3.3/\Omega\text{cm}$  to  $1.3 \times 10^2/\Omega\text{cm}$ .

81. A method for producing a gallium nitride group compound semiconductor according to claim 55, wherein said electron concentration is ranging from  $6 \times 10^{16}/\text{cm}^3$  to  $3 \times 10^{18}/\text{cm}^3$ .

82. A method for producing a gallium nitride group compound semiconductor according to claim 56, wherein said electron concentration is ranging from  $6 \times 10^{16}/\text{cm}^3$  to  $3 \times 10^{18}/\text{cm}^3$ .

83. A method for producing a gallium nitride group compound semiconductor according to claim 59, wherein said electron concentration is ranging from  $6 \times 10^{16}/\text{cm}^3$  to  $3 \times 10^{18}/\text{cm}^3$ .

84. A method for producing a gallium nitride group compound semiconductor according to claim 60, wherein said electron concentration is ranging from  $6 \times 10^{16}/\text{cm}^3$  to  $3 \times 10^{18}/\text{cm}^3$ .

85. A method for producing a gallium nitride group compound semiconductor according to claim 63, wherein said electron concentration is ranging from  $6 \times 10^{16}/\text{cm}^3$  to  $3 \times 10^{18}/\text{cm}^3$ .

86. A method for producing a gallium nitride group compound semiconductor according to claim 64, wherein said electron concentration is ranging from  $6 \times 10^{16}/\text{cm}^3$  to  $3 \times 10^{18}/\text{cm}^3$ .

87. A method for producing a gallium nitride group compound semiconductor according to claim 53, wherein said gallium nitride group compound semiconductor is formed on or above a buffer layer which is formed on a sapphire substrate.

88. A method for producing a gallium nitride group compound semiconductor according to claim 54, wherein said gallium nitride group compound semiconductor is formed on or above a buffer layer which is formed on a sapphire substrate.

89. A method for producing a gallium nitride group compound semiconductor according to claim 55, wherein said gallium nitride group compound semiconductor is formed on or above a buffer layer which is formed on a sapphire substrate.

90. A method for producing a gallium nitride group compound semiconductor according to claim 56, wherein said gallium nitride group compound semiconductor is formed on or above a buffer layer which is formed on a sapphire substrate.

91. A method for producing a gallium nitride group compound semiconductor according to claim 57, wherein said gallium nitride group compound semiconductor is formed on or above a buffer layer which is formed on a sapphire substrate.

92. A method for producing a gallium nitride group compound semiconductor according to claim 58, wherein said gallium nitride group compound semiconductor is formed on or above a buffer layer which is formed on a sapphire substrate.

93. A method for producing a gallium nitride group compound semiconductor according to claim 59, wherein said gallium nitride group compound semiconductor is formed on or above a buffer layer which is formed on a sapphire substrate.

94. A method for producing a gallium nitride group compound semiconductor according to claim 60, wherein said gallium nitride group compound semiconductor is formed on or above a buffer layer which is formed on a sapphire substrate.

95. A method for producing a gallium nitride group compound semiconductor according to claim 61, wherein said gallium nitride group compound semiconductor is formed on or above a buffer layer which is formed on a sapphire substrate.

96. A method for producing a gallium nitride group compound semiconductor according to claim 62, wherein said gallium nitride group compound semiconductor is formed on or above a buffer layer which is formed on a sapphire substrate.

97. A method for producing a gallium nitride group compound semiconductor according to claim 63, wherein said gallium nitride group compound semiconductor is formed on or above a buffer layer which is formed on a sapphire substrate.

98. A method for producing a gallium nitride group compound semiconductor according to claim 64, wherein said gallium nitride group compound semiconductor is formed on or above a buffer layer which is formed on a sapphire substrate.

99. A method for producing a gallium nitride group compound semiconductor according to claim 87, wherein said buffer layer is formed on said sapphire substrate by using an

organometallic compound vapor phase epitaxy at a growth temperature lower than that of said gallium nitride group compound semiconductor.

100. A method for producing a gallium nitride group compound semiconductor according to claim 88, wherein said buffer layer is formed on said sapphire substrate by using an organometallic compound vapor phase epitaxy at a growth temperature lower than that of said gallium nitride group compound semiconductor.

101. A method for producing a gallium nitride group compound semiconductor according to claim 89, wherein said buffer layer is formed on said sapphire substrate by using an organometallic compound vapor phase epitaxy at a growth temperature lower than that of said gallium nitride group compound semiconductor.

102. A method for producing a gallium nitride group compound semiconductor according to claim 90, wherein said buffer layer is formed on said sapphire substrate by using an organometallic compound vapor phase epitaxy at a growth temperature lower than that of said gallium nitride group compound semiconductor.

103. A method for producing a gallium nitride group compound semiconductor according to claim 91, wherein said buffer layer is formed on said sapphire substrate by using an organometallic compound vapor phase epitaxy at a growth temperature lower than that of said gallium nitride group compound semiconductor.

104. A method for producing a gallium nitride group compound semiconductor according to claim 92, wherein said buffer layer is formed on said sapphire substrate by using an organometallic compound vapor phase epitaxy at a growth temperature lower than that of said gallium nitride group compound semiconductor.

105. A method for producing a gallium nitride group compound semiconductor according to claim 93, wherein said buffer layer is formed on said sapphire substrate by using an organometallic compound vapor phase epitaxy at a growth temperature lower than that of said gallium nitride group compound semiconductor.

106. A method for producing a gallium nitride group compound semiconductor according to claim 94, wherein said buffer layer is formed on said sapphire substrate by using an organometallic compound vapor phase epitaxy at a growth temperature lower than that of said gallium nitride group compound semiconductor.

107. A method for producing a gallium nitride group compound semiconductor according to claim 95, wherein said buffer layer is formed on said sapphire substrate by using an organometallic compound vapor phase epitaxy at a growth temperature lower than that of said gallium nitride group compound semiconductor.

108. A method for producing a gallium nitride group compound semiconductor according to claim 96, wherein said buffer layer is formed on said sapphire substrate by using an

organometallic compound vapor phase epitaxy at a growth temperature lower than that of said gallium nitride group compound semiconductor.

109. A method for producing a gallium nitride group compound semiconductor according to claim 97, wherein said buffer layer is formed on said sapphire substrate by using an organometallic compound vapor phase epitaxy at a growth temperature lower than that of said gallium nitride group compound semiconductor.

110. A method for producing a gallium nitride group compound semiconductor according to claim 98, wherein said buffer layer is formed on said sapphire substrate by using an organometallic compound vapor phase epitaxy at a growth temperature lower than that of said gallium nitride group compound semiconductor.

111. A method for producing a gallium nitride group compound semiconductor according to claim 19, wherein silicon-containing gas is silane ( $\text{SiH}_4$ ).

112. A method for producing a gallium nitride group compound semiconductor according to claim 20, wherein silicon-containing gas is silane ( $\text{SiH}_4$ ).

113. A method for producing a gallium nitride group compound semiconductor according to claim 53, wherein silicon-containing gas is silane ( $\text{SiH}_4$ ).



114. A method for producing a gallium nitride group compound semiconductor according to claim 54, wherein silicon-containing gas is silane ( $\text{SiH}_4$ ).

115. A method for producing a gallium nitride group compound semiconductor according to claim 55, wherein silicon-containing gas is silane ( $\text{SiH}_4$ ).

116. A method for producing a gallium nitride group compound semiconductor according to claim 56, wherein silicon-containing gas is silane ( $\text{SiH}_4$ ).

117. A method for producing a gallium nitride group compound semiconductor according to claim 63, wherein said electron concentration is not less than  $6 \times 10^{16}/\text{cm}^3$ .

118. A method for producing a gallium nitride group compound semiconductor according to claim 64, wherein said electron concentration is not less than  $6 \times 10^{16}/\text{cm}^3$ .